

New approaches to the formation of sustainable innovative development of the oil and gas chemical complex enterprises of the Republic of Tatarstan

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Abstract. The article deals with the problems of increasing the sustainability of the innovative development of the regional industrial complex in the context of technological diversification. It is assumed that the introduction of sustainable innovations will allow the complex under study to increase efficiency and competitiveness in the face of existing restrictions due to the integrated and balanced development of socio-ecological and economic aspects of activity. For these purposes an analysis of the factors limiting the introduction of innovations is carried out. As a result, it is concluded that the focus of companies on environmental innovation in the course of innovation can not only improve the quality of the development of the region's ecosystem, but also lead to an increase in the economic effect.

1 Introduction

At present the modern development of domestic enterprises of the petrochemical complex is accompanied by the emergence of disturbances and risks. The current economic and political conditions increase the level of uncertainty, which has a significant impact on ensuring stable and balanced development. At the same time, it should be noted that the existing restrictions contribute to the search for new ways and directions of development to ensure the economic security of the petrochemical complex and the country as a whole.

The departure of foreign companies provides opportunities for domestic enterprises to create new technology platforms and create innovative development impulses based on replacement technology. This, in turn, leads to the formation of the basis for the transition to a new quality of innovative development - sustainable innovation.

Such favourable conditions for the replacement of imported equipment and technologies with modern domestic developments make it possible to create new packages of innovations that lead to sustainable innovative development through a comprehensive and balanced change in companies. At the same time, their implementation will increase the added value and increase the quantity, quality, range of innovative products and services provided. To do this, it is necessary to search for the bottlenecks and turn them into points of growth within

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the framework of implemented innovative solutions. The implementation of this transformation can be ensured through the development and application of new approaches to innovation management. These approaches can be implemented through the use of organizational and economic mechanisms for introducing sustainable innovations, which will ensure a qualitatively new development of enterprises [1,2]. The transition to sustainable development based on innovation will allow not only to achieve long-term development goals, but to expand and create new markets.

2 Materials and methods

When studying the current state of the management system, the following methods were used to solve the tasks at various stages of the study: system analysis, the method of statistical analysis, the method of quantitative risk assessment; method of qualitative risk assessment; method of complex economic analysis, method of modelling, method of situational analysis, comparative analysis, method of expert assessments, methods of mathematical statistics. At the same time, the method of system analysis allows, within the framework of the study, to decompose the considered production and economic systems, to identify the relationship between the selected elements, to determine their functions in managing emerging risks, the goals and resources necessary to form a system for balanced management of them. This method is based on a set of general scientific, experimental, natural science, statistical, mathematical methods, so it is necessary when considering issues related to the system of balanced management of innovative sustainable development. The methods of statistical analysis and mathematical statistics are technologies and tools for analysing a large array of numerical data describing various processes. However, even at present, these methods are widely used to identify patterns of change in various systems, which include systems of balanced also to determine the quality of development of production and economic systems.

Method of comparative analysis is a method of studying objects, which compares the new state of the object with the old state or compares the state of one object with another, with which the comparison may be appropriate. Thus, this method makes it possible to compare the effectiveness of individual management measures and their whole complex for the balanced management of sustainable innovations in order to achieve sustainable development of various production and economic systems [3].

3 Results

Using the methods and materials presented above, the main approaches to the formation of sustainable development in modern conditions were studied. In general terms, sustainable development is a process of economic and social change in which the exploitation of natural resources, the direction of investment, the orientation of scientific and technological development, and the development of the individual and institutional changes are consistent with each other and strengthen the current and future capacity to meet human needs and aspirations.

In this regard, we analysed the main factors that hinder the introduction of environmental innovations in enterprises. The most significant/major or decisive factors are those described in Table 1.

Table 1. Factors hindering the introduction of environmental innovations.

Factors hindering the introduction of environmental innovations	Ratio
The high cost of innovation	4.11

Lack of own funds	3.4
High economic risk	3.13
High competition in the market	1.81
Lack of financial support from the state	1.77
Low demand for new goods, works, services	1.41
Average level of influence	-
Uncertainty of economic benefits from the use of intellectual property	1.26
Lack of qualified personnel	1.15
Lack of credit or direct investment	0.87
Low innovative potential of the enterprise	0.87
Minor impact	
Lack of market information	0.57
Underdevelopment of cooperation ties	0.57
Lack of information about new technologies	0.69
Underdevelopment of innovative infrastructure (intermediary, information, legal, banking, other services)	0.7
Insufficiency of legislative and regulatory documents regulating and stimulating innovation activity	0.72
Inconsistency with organizational priorities	0.72

After analysing the ratio of factors that have either a significant or insignificant relationship, we can conclude that the main factors that hinder the introduction of environmental innovations are related to financial aspects. Thus, according to the heads of leading domestic enterprises, the most important limitation that has a significant impact on the introduction of innovations is the high cost of innovations [4]. And this, in the conditions of a lack of own funds and a high level of uncertainty in the economic system, leads to an increase in financial risks. At the same time, the dynamics of the reduction of own funds allocated for innovation activities in the Republic of Tatarstan led not only to a decrease in its efficiency, but also to a reduction in innovation activity. It should also be noted that the data for 2021 indicate that high competition in the markets reduces the activity of implementing innovative activities. However, at this stage of development, significant structural changes took place in the domestic economy. They are associated with the withdrawal of foreign companies from the Russian market, which led to a drop in the availability of modern foreign technologies. However, the analysis of the factors hindering innovation from form No. 4 "Innovations" shows that domestic enterprises have sufficient information about the sales markets and the development of modern technologies. Therefore, it is necessary to intensify the development and implementation of our own advanced process and product innovations. Moreover, there are all the prerequisites for this. For example, respondents believe that we have an average level of innovation potential and staff qualifications [5,6]. And these factors, in modern conditions, can serve as catalysts for improving the efficiency of innovation. And they can be increased on the basis of the use and development of existing cooperative ties between enterprises, the state and scientific organizations.

The current economic situation provides additional opportunities for solving existing problems. It also causes the effects of innovation. For example, as modern research shows, obtaining social and environmental effects, together with an increase in economic performance, can lead to long-term financial viability [7,8]. Therefore, in our opinion, it is necessary to analyse innovations in the Republic of Tatarstan, which are aimed at improving the environment. Ecological innovations contribute not only to the development of the region's ecosystem, but also provide additional economic benefits, shown in Figure 1.

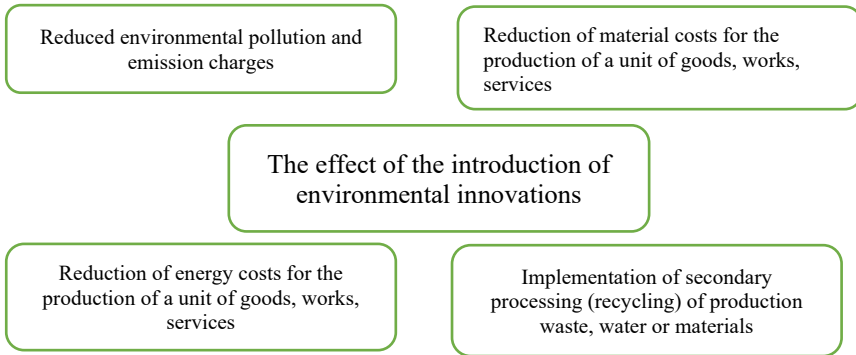


Fig. 1. Classification of economic effects from the introduction of environmental innovations.

As it can be seen from Figure 1, the development and implementation of environmental innovations can reduce production costs. At the same time, the environmental component of the overall effect is mandatory in those innovations that are based on complex technological systems, contain environmental risk, a high probability of accidents and severe consequences [9,10]. The simultaneous effect is of particular relevance for enterprises with high energy and material intensity, which includes the petrochemical complex of the NGCC of the Republic of Tatarstan. Therefore, as part of our study, it is necessary to analyse the environmental aspects and special costs that are associated with innovations aimed at improving the environment in the Republic of Tatarstan.

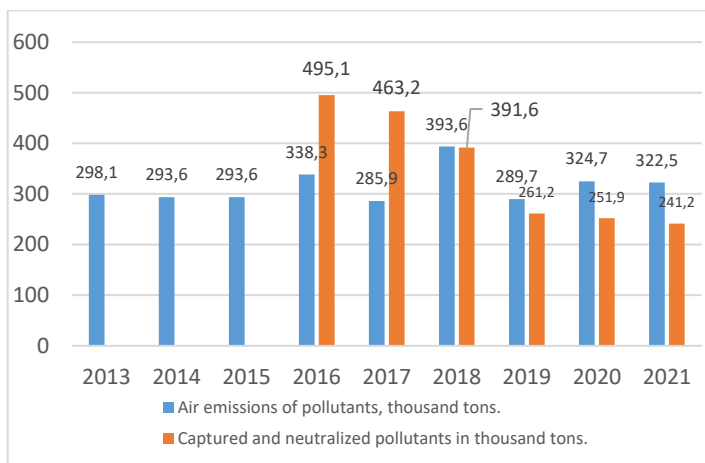


Fig. 2. The amount of emitted and captured air pollutants from stationary sources in the Republic of Tatarstan.

An analysis of the data of state reports on environmental protection of the Republic of Tatarstan indicates that there is a decrease in the volume of captured and neutralized pollutants. This is due to the increase in the depth of processing in the fuel, chemical and petrochemical industries. Thus, the intensity of atmospheric emissions per unit of gross regional product in 2013 was 0.19 thousand tons/billion rubles and in 2021 it decreased to 0.11 thousand tons/billion rubles. Thus, the reduction was more than 70%. The industries that make the largest contribution to the GRP of the Republic of Tatarstan made the greatest contribution to the reduction of emissions. These include fuel, chemical, petrochemical and thermal power industries. Figure 3 shows the dynamics of emissions of pollutants into the atmosphere in the fuel, chemical and petrochemical complexes.

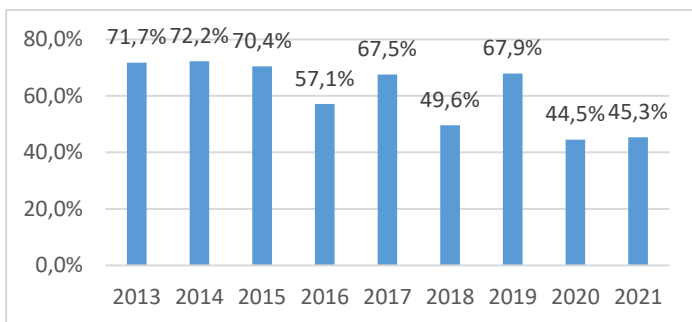


Fig. 3. Dynamics of changes in the amount of emissions into the atmosphere in the fuel, chemical and petrochemical complexes of the Republic of Tatarstan.

The data show that there is a significant decrease in the share of emissions of pollutants into the atmosphere during the study period. Thus, emissions in 2020-2021 compared to emissions in 2013-2014 decreased by more than 60%. First of all, this is due to the modernization and repair of existing facilities. However, an additional reduction in emissions is ensured through the introduction of innovation, as well as the introduction of new modern equipment and technologies.

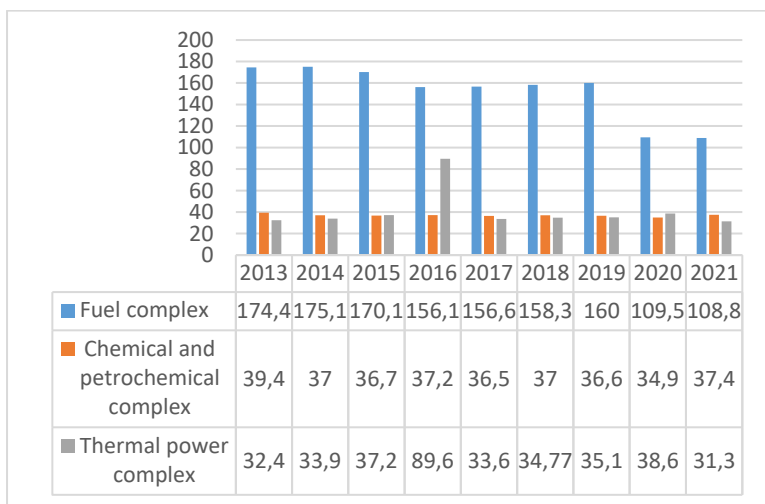


Fig. 4. Volume of emissions of pollutants into the atmosphere by fuel, chemical and petrochemical complexes.

The best dynamics in reducing emissions is observed in the fuel industry, which has more than a hundred enterprises. Leading enterprises of the industry PJSC Tatneft, LLC Gazprom transgaz Kazan, JSC Transfnet-Prikamye. The total contribution of fuel industry enterprises to the emissions of pollutants into the atmosphere during the study period decreased from 58.5% to 33.8%, despite the fact that the volume of production increased during this time. The main factor contributing to the positive dynamics is the existing installations for capturing light fractions of hydrocarbons and the further use of associated gas. If in previous periods it was burned, then at the moment enterprises are introducing modern technologies for its use. For example, PJSC Tatneft directs its efforts to increase the utilization and beneficial use of associated petroleum gas for injection into oil-bearing formations to maintain in-situ pressure, and the production of gas piston units at gas power plants. OOO Gazprom transgaz Kazan uses it for its own needs as a fuel for heating furnaces [11,12].

The chemical and petrochemical complex includes sixteen large enterprises. The main ones are: Nizhnekamskneftekhim PJSC, TANECO OJSC, Organic Synthesis PJSC Kazan, Nizhnekamsktehuglerod OJSC and others. The total contribution of enterprises of the chemical and petrochemical complex for the period under study to the emissions of pollutants into the atmosphere decreased slightly from 13.2% to 11.6%. However, they are characterized by emissions of hazardous substances, such as saturated and unsaturated hydrocarbons, phenol, ammonia, acetone, etc. New equipment and technologies are introduced annually at these enterprises to reduce the amount of emissions of harmful pollutants. The main types of work are related to the transition to less hazardous raw materials, the installation of equipment and the change in technology for the reuse of raw materials, etc.

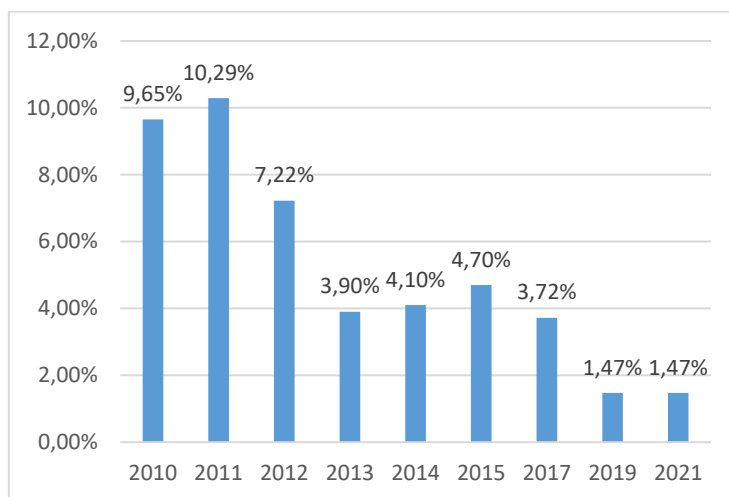


Fig. 5. The share of organizations that carried out innovations aimed at improving the environment by years in the total volume of surveyed enterprises.

Figure 5 shows that every year there is a reduction in the number of enterprises that introduce innovations aimed at improving the environment. This negatively affects not only the state of the environment in the region, but also makes it impossible to use the recycling of production waste and reduce energy costs per unit of production.

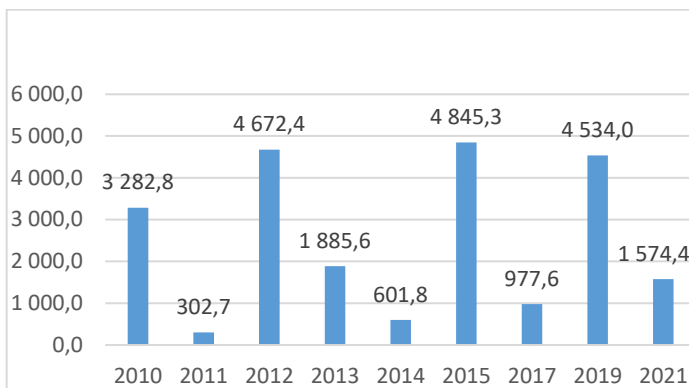


Fig. 6. Special costs associated with innovations aimed at improving the environment in the Republic of Tatarstan.

According to the annual form of federal statistical observation No. 4 of innovation, information, starting from 2016, is submitted at intervals of once every two years for odd years. The data in the figure show that the costs of innovation in the field of ecology vary greatly from year to year. At the moment, there is no clear trend to increase the cost of innovation. However, as described above, environmental innovation can improve the financial performance of the organization. Unfortunately, enterprises of the Republic of Tatarstan do not use the potential inherent in solving environmental problems and at the same time reducing material and energy costs per unit of output. This is confirmed by Figure 7.

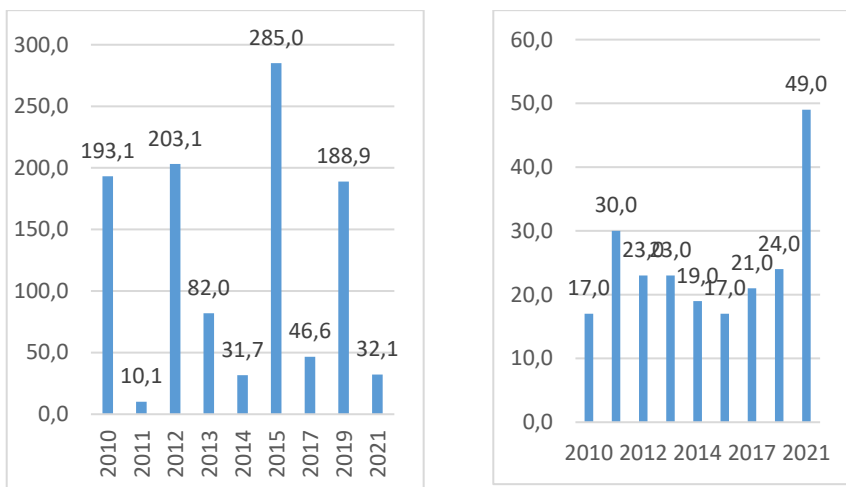


Fig. 7. a) Special costs associated with innovations aimed at improving the environment per organization in million rubles, **b)** Number of organizations that had special costs for environmental innovations.

According to Figure 7, there is an increase in companies implementing environmental innovations, which is not accompanied by a similar increase in innovation costs. This is most likely due to the discrete and short-term nature of innovative changes, with the lack of a complex impact on the company's processes. This leads to a reduction in the effect of innovative development and may lead to a decrease in its sustainability.

4 Conclusion

In general, current trends in the development of the petrochemical complex show that the reduction of the technological dependence of the national economy in critical areas is directly related to the introduction of innovative environmental projects. At the same time, these studies clearly show that their implementation allows not only to increase the competitiveness and financial viability of enterprises, but also creates new opportunities for innovative technological development in the long term [13,14]. However, to achieve the desired efficiency of ecosystem development, it is necessary to take into account all the hidden opportunities and challenges that exist in modern economic conditions. In this regard, the implementation of investment projects based on sustainable innovations is relevant, since, as noted above, they allow solving complex development problems.

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